OLQ Geological Services
Technical Memorandum
Revised November 30,1999

Manufactured Gas Plants

Introduction

Before natural gas was commonly available for heating, cooking, and illumination, many municipal utilities produced gas at local manufactured gas plants (MGPs). Although long closed, some of these sites still contain significant subsurface contamination. This paper gives a very brief introduction to the environmental problems which may be presented by these sites.

History

The localized production of manufactured or ”town” gas began in this country around 1820, and although most production ended in the 1950's, some lasted until the early 1960's, when the last manufactured gas plants were replaced by the expanding natural gas pipeline system. The EPA states that there were about 1500 MGPs, mostly in the Midwest and east, but the gas industry itself estimates double that number.

Waste Products

Combustible gas was produced by the heating of coal, coke, or oil. The rather dirty process used various retorts, condensers, tar extractors, washers, scrubbers and purifiers. The waste products depended on the type of production system used, as detailed in Table 1. A more chemically detailed listing is presented in Table 2. Although polycyclic aromatic hydrocarbons (PAHs) from the varied tars are the most common, and environmentally persistent contaminant; BETX, cyanide, metals, VOCs, and sulfur compounds are often also present.

The management of the MGP waste or process residuals was dependant on the economics of the time. If the by-products could be sold, they were. If prices were low or non-existent, the same materials were disposed of, usually on-site. Large amounts of tar were generated by MGPs, and efforts were made to sell it, but quality and consistency were usually poor, so production greatly exceeded demand.

The excess tar was left in the tar separator units (usually basins in the ground) or stored in on-site “tar wells” or pits. When the plants closed, their pits, wells, and basins, together with most other underground storage, were normally topped off by debris from the above-ground facilities, and left in place (Edison Electric Institute, 1993). At one MGP site in Indiana, exploratory drilling hit one of the pits, and site storm drains were running with black coal tar sludge.

Remediation

Most of the pollutants resulting from MGPs do not pose inordinate remediation problems, but the

physical and chemical characteristics of the tar waste, (particularly the solubility, viscosity, and density) make remediation of MGP tars a definite challenge. Many of the tars are not water soluble, making most water-based remediation invalid. Pump and treat will only remove a fraction of the tar, the same for steam stripping or soil flushing. The tars are very low in volatiles, so sparging and vapor extraction also do not work well. (Luthy, et. al. 1994)

Bioremediation does not significantly affect most PAHs, because the microbes need water, and the PAHs are not readily soluble in water, so they are not accessible to the microbes. Some compounds such as 2-methylnapthalene, 1-methylphenanthrene, fluorene, anthracene, acenaphythylene, acenapthene, phenanthrene and phenylnapthalene are somewhat biodegradable, while pyrene, fluoranthene, benzo (a) pyrene and benzo (g,h,i) perylene do not appreciably biodegrade at all. Mixtures of these non-biodegradable compounds can also hinder biodegradation of other compounds which are biodegradable. (Kilbane, et. al. 1997)

The remediation methods traditionally used on MGP tars include excavation, followed by combustion, landfilling, or recycling (asphalt or bricks). These remedies have shortcomings. BTUs may be low due to admixed soil, landfill disposal costs can be high, and recycling and co-combustion may be hindered by permitting and liability problems. (Vogel and Peramaki, 1998)

The total volume of waste to be treated can also be a problem, particularly for any remediation involving excavation. The gas industry has published papers claiming that PAH migration is theoretically limited. However, the high density can result in significant vertical migration. At one Indiana MGP site with sandy subsoil, PAHs were found at eighty feet below the surface; much too deep for excavation.

In-situ treatment is still a problem. The Gas Research Institute is trying combined approaches of solvent or surfactant flushing followed by bio-stimulation. Phytoremediation is also being tried (Boyajian and Summer, 1998), and thermal desorption, but these ideas remain experimental.

Capping and containment have been used in the past, but limits re-use of the property. A risk-based approach may prove promising, particularly when combined with initial remediation of as much contamination as possible.

If you have any questions involving MGP sites, please contact Science Services for assistance.

TABLE 1

Process residuals from the manufacture of gas from coal, coke, and oil

Process residuals	Physical form and principal chemical content	Gas manufacturing process		
		Coal carbonization	Carbureted water gas	Oil gas
Ammonia liquors	Aqueous liquid: inorganics, phenolics	X[a]	—	—
Ash and clinker	Solid: metals (and unburned coke or coal)	X	X	—
Carbureted water gas tar	Organic liquid: PAHs, BTEX[b]	—	X	—
Coal tar	Organic liquid: PAHs, BTEX, and phenolics	X	—	—
Coke and coke breeze	Solid: pyrolyzed coal	X	—	—
Lampblack	Sludge: elemental carbon and oil tar	—	—	X
Light oils	Organic liquid: BTEX	X	X	X
Oil tar	Organic liquid: PAHs, BTEX	—	—	X
Spent oxide or lime, wood chips (support media)	Solid: metals, cyanide, sulfur, tar	X	X	—
Tar sludges	Solid–liquid: PAHs, BTEX	X	X	X
Tar–oil–water emulsions	Aqueous and organic liquids: PAHs, BTEX	X	X	X
Wastewater treatment sludges	Solids, aqueous, and organic liquids: inorganics, phenolics, PAHs, BTEX	X	X	X

[a] "X" indicates that residual was produced; — indicates that residual was not produced in substantial amounts.
[b] PAH = polycyclic aromatic hydrocarbons; BTEX = benzene, toluene, ethylbenzene, and xylene.

Luthy et al, 1994

Table 2 WASTES AND CHEMICALS OF INTEREST AT MGP SITES

WASTES	• Free tars, oils, and lampblack	• Organic-contaminated vessel, surface, and ground waters
	• Organic-contaminated soils - Heavily contaminated - Lightly contaminated	• Purifier wastes
		• Mixed wastes and fill

CHEMICALS	• INORGANICS	• METALS	• VOLATILE AROMATICS	• PHENOLICS	• POLYNUCLEAR AROMATIC HYDROCARBONS
	Ammonia	Aluminum	Benzene	Phenol	Acenaphthene
	Cyanide	Antimony	Ethyl Benzene	2-Methylphenol	Acenaphthylene
	Nitrate	Arsenic	Toluene	4-Methylphenol	Anthracene
	Sulfate	Barium	Total Xylenes	2,4-Dimethylphenol	Benzo(a)anthracene
	Sulfide	Cadmium			Benzo(a)pyrene
	Thiocyanates	Chromium			Benzo(b)fluoranthene
		Copper			Benzo(g,h,i)perylene
		Iron			Benzo(k)fluoranthene
		Lead			Chrysene
		Manganese			Dibenzo(a,h)anthracene
		Mercury			Dibenzofuran
		Nickel			Fluoranthene
		Selenium			Fluorene
		Silver			Naphthalene
		Vanadium			Phenanthrene
		Zinc			Pyrene
					2-Methyl naphthalene

Kilbane et al, 1997

REFERENCES

Boyajian, G. E., and Summer, R. B. 1998. Phytoremediation Can Be Designed for MGP Site Contaminants. *Soil & Groundwater Cleanup.* June pp. 16-19.

Edison Electric Institute. 1993. MGP Site Remediation Strategy Memo. 13 p.

Kilbane, J. J., Paterek, J. R., and Srivastava, V. J. 1997. Microbial Enhancement of Waste Degradation at Manufactured Gas Plan Sites. Institute of Gas Technology. 128 p.

Luthy, R. G., Dzombak, D. A., Peters, C. A., Roy, S. B., and Ramaswami, A. 1994. Remediating Tar-Contaminated Soils at Manufactured Gas Plant Sites. *Environmental Science and Technology.* Volume 23, No. 6, pp. 266-275.

U. S. EPA 1993. Letter from Lowrance, S.K. 3 p.

Vogel, K. D., and Permaki, M. P. 1998. Polyaromatic Hydrocarbons - They are not so impossible. *Soil & Groundwater Cleanup.* December/January, pp. 26-30.